Final Report
of a project entitled

WINDBLOWN FEATURES ON VENUS AND GEOLOGICAL MAPPING
(NASA NAG5 4156)

covering the period through June, 1999

submitted by

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The objectives of this study were to: 1) develop a global data base of aeolian features by searching Magellan coverage for possible time-variable wind streaks, 2) analyze the data base to characterize aeolian features and processes on Venus, 3) apply the analysis to assessments of wind patterns near the surface and for comparisons with atmospheric circulation models, 4) analyze shuttle radar data acquired for aeolian features on Earth to determine their radar characteristics, and 5) conduct geological mapping of two quadrangles.

Wind, or aeolian, features are observed on Venus and aeolian processes play a role in modifying its surface. Analysis of features resulting from aeolian processes provides insight into characteristics of both the atmosphere and the surface. Wind related features identified on Venus include erosional landforms (yardangs), depositional dune fields, and features resulting from the interaction of the atmosphere and crater ejecta at the time of impact. The most abundant aeolian features are various wind streaks. Their discovery on Venus afforded the opportunity to learn about the interaction of the atmosphere and surface, both for the identification of sediments and in mapping near-surface winds.

There is debate concerning the amount and location of weathered material on Venus, particularly in relation to fine sediments. Although volcanic and tectonic processes dominate the surface history, exogenic processes (including wind) and the generation of sediments appear to be important in some

areas, such as in association with parabolic ejecta deposits. In addition to these deposits, wind streaks signal the presence of fine sediments that were subject to wind transport at the time of their formation. Although wind streaks are concentrated near impact craters (we assume that crater ejecta includes fine particles), streaks are also found at most longitudes and latitudes on Venus. Thus, fine-grained sediments may be ubiquitous as a thin mantle (too thin to modify the primary volcanic-tectonic surface morphology).

It is not known if sediments on Venus are currently active. However, observation of dust in the atmosphere raised during landing of the Venera spacecraft demonstrates that loose sediments are available for wind transport. Moreover, measured wind speeds on Venus are well within the range predicted for sediment transport, based on Venus wind tunnel experiments. On the other hand, some of the extensive smooth, featureless venusian plains could be sediments that have been lithified by a process unique to Venus, such as "cold welding," a process simulated in laboratory experiments under venusian conditions or by a cementation process.

The general approach in this study involved searching Magellan SAR data for wind streaks, analyzing the data base to infer local, regional, and global patterns of near-surface winds, correlating aeolian features with geological setting, deriving aerodynamic roughness values from Magellan radar backscatter measurements for use in predictive models of windblown sediment on Venus, and synthesizing the results for assessing aeolian activity on Venus and its role in surface modification.

Results

Results from this investigation are given in the attached publications, and as noted here: A general survey of wind-related features seen on the Magellan radar images was presented by Greeley et al. (1995 and 1997). This was then used to as input to an assessment of the general circulation of the atmosphere (Gierasch et al., 1997). A general synthesis of aeolian processes on the terrestrial planets, including Venus, was published by Greeley et al., (1995), and a study of dunes and microdunes observed in the Magellan data was presented by Weitz et al. (1994).

Geological mapping was completed for two quadrangles, as part of the U.S.G.S. planetary mapping program. The Carson quadrangle (V-43) has been reviewed, revised and is currently in press as U.S. Geol. Survey Map I-2620. The second map, the Alpha Regio quadrangle (V32), has been reviewed and is currently being revised.

Publications

Bender, K.C., D.A. Senske, and R. Greeley, 1999, Geology of the Carson Quadrangle, Venus, *U.S. Geol. Survey Map I-2620* (in press).

Bender, K.C., K. Homan, and R. Greeley, 1999, Geology of the Alpha Regio Quadrangle, Venus, *U.S. Geol. Survey Map* (in revision).

Gierasch, P.J., et al., 1997, The general circulation of the Venus atmosphere: An assessment, In *Venus II: Geology, Geophysics, Atmosphere, and Solar Wind Environment,* S.W. Bougher, D.M. Hunten, and R.J. Phillips, Eds., Tucson: Univ. of Arizona Press, 459-500.

Greeley, R., 1995, Geology of terrestrial planets with dynamic atmospheres, *Earth, Moon, and Planets, 67,* 13-29.

Greeley, R., K. Bender, P.E. Thomas, G. Schubert, D. Limonadi, and C.M. Weitz, 1995, Wind-related features and processes on Venus: Summary of Magellan results, *Icarus, 115,* 399-420.

Greeley, R., K.C. Bender, R.S. Saunders, G. Schubert, and C.M. Weitz, 1997, Aeolian processes and features on Venus, In *Venus II: Geology, Geophysics, Atmosphere, and Solar Wind Environment,* S.W. Bougher, D.M. Hunten, and R.J. Phillips, Eds., Tucson: Univ. of Arizona Press, 547-589.

Weitz, C.M., J.J. Plaut, R. Greeley, and R.S. Saunders, 1994, Dunes and microdunes on Venus: Why were so few found in the Magellan data?, *Icarus, 112,* 282-295.